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### THE AURORA OF SEPTEMBER 18, 1941

The aurora visible over the entire sky at Washington on the evening of September 18 was of great interest in connection with the Bureau's studies of radio-wave propagation. Auroras are caused by the electrical excitation of atoms in the rare part of the atmosphere known as the ionosphere. The ionosphere is that portion of the atmosphere from about 30 to 300 miles above the ground, which reflects radio waves and makes long-distance radio possible.

Aurora and the accompanying radio, magnetic, and electric disturbances are manifestations of a turbulent condition in the ionosphere. This turbulence is caused by the arrival in the outer atmosphere of charged electric particles. These particles come from the sun, and are usually most prevalent when there are large active sunspots (i. e., sunspots in which visible changes are occurring, new spots being born, etc.). A group of large active sunspots appeared at the edge of the sun September 10. As the sun has one revolution in about 27 days the sunspot group was about at the center of the sun September 17.

Tremendous quantities of electric particles were pouring forth from the sun at that time. In the northeastern United States, the aurora was observed nightly starting September 15, and radio reception from European stations was weak, accompanied by a rushing or roaring electrical noise on the high radio frequencies. At 1 a. m. EST on September 18 there was a sudden tremendous increase in the number of electric particles entering the earth's atmosphere from the sun. As a result, the ionosphere was violently agitated, the aurora became visible at Washington, and sky-wave radio transmission was severely disturbed. As the day went on, the disturbances increased, culminating in an extremely brilliant auroral display in the evening and a complete disruption of the ionosphere and of radio transmission.

The auroral display was probably the most brilliant ever observed at Washington. Just after sunset a steady curtain of light appeared in an arc low in the northern sky. Then long bright shafts began to appear and disappear, and the display began to move southward toward the zenith. Shortly before 8 p. m. rays and streamers were visible

<sup>1</sup> Published with approval of the Director of the Budget.

over most of the sky. Flickering waves of green light appeared to travel upward toward the zenith along the rays. The peak of the display was about 8:15 p. m., and then the aurora began to fade out, most of it disappearing by 11 p. m.

When the aurora was at the peak, the rays seemed to converge to a point near the zenith at about 70° above the southern horizon, and slightly to the east. The reason for this is that the incoming charged particles followed the earth's magnetic field; and the rays, which appear along the paths of these particles, are thus everywhere parallel to the earth's field. At Washington, the earth's magnetic field is inclined at 70° to the horizontal and runs from slightly south of east to the northwest. To an observer, then, it seemed as if he stood in the midst of a number of parallel lines of light, whose direction was that of the earth's field. At times of such an aurora it is thus possible to "see" the earth's magnetic field, just as iron filings enable one to "see" the field of a small bar magnet in a laboratory experiment.

A study of the effects accompanying this and other auroras has led to an understanding of what happens. Radio communication is adversely affected, not only during the aurora but for several days afterward. While no aurora was visible at Washington after September 18, high-frequency radio transmission was unusually poor for a week thereafter. Thus the aurora is only an evidence of the first stage of an ionosphere storm, the stage in which there is a tremendous increase in the number of electric particles entering the ionosphere. These particles plunging into the ionosphere tear up the regular ionized layers which normally reflect radio waves, and also produce intense ionization at unusually low levels, which uses up the energy of radio waves, thus reducing their intensity in addition to causing severe fluctuations.

During this turbulent stage of the ionosphere storm, high-frequency radio is very erratic, both signals and "static" surge violently, being transmitted with good intensity for short intermittent periods, interspersed with periods of complete failure. This indicates severe turbulence in the ionosphere with small unstable patches, or clouds, of high ionization densities. Fluttery transmissions can be heard at frequencies far in excess of those normally useful for long-distance communication. Not only auroral but the most severe fluctuations of terrestrial magnetism occur

during this first, or turbulent, stage of the ionosphere storm.

The second stage, following the turbulent stage of an ionosphere storm, is characterized by an expansion and diffusion of the higher ionosphere, extending into latitudes farther south, the greater the intensity of the storm. This expansion and diffusion of the ionosphere increases the virtual heights and lowers the ionization densities of the ionosphere layers. The maximum usable frequencies for night *F*-layer and daytime *F*<sub>2</sub>-layer transmissions are much reduced because of the lowered critical frequencies and increased virtual heights. Thus the higher frequencies are not usable. Frequencies low enough to be received are usually abnormally absorbed, especially during the daytime. There is usually increased fading and instability of transmissions over night paths. Sky-wave field intensities at broadcast frequencies rise much later at night and reach values much lower than normal.

This second, or moderate, stage, of the ionosphere is what lasts several days. It exists at latitudes as far south as Washington much more frequently than the first, or turbulent, stage, just as the aurora, which is associated with the first stage, is seldom seen in Washington.

#### LOCATING THE PRINCIPAL POINT OF AIRPLANE MAPPING CAMERAS

The demand for increased accuracy in maps from airplane photographs has resulted in steady improvement of the airplane mapping camera. The use of better lenses was soon followed by a desire for specific information on the location of the principal point of the image plane with respect to the collimation index markers mounted on the four sides of the focal plane frame. The principal point of the image plane, defined as that point where a perpendicular dropped from the rear nodal point of the lens intersects the image plane, is not readily located, but a method has been developed by Francis E. Washer of the Bureau's Optical Instruments Section by which this can be accomplished.

The chief factors in the location of the principal point are (1) to locate the image of an infinitely distant object, lying on a perpendicular to the image plane, with respect to the collimation index markers of the camera, and (2) to determine how much the position of this image is altered by prism effect in

the lens. A method for measuring these quantities has been devised and tried on a total of 40 or more precision airplane mapping cameras that are to be used on various governmental mapping projects. The method is described and tabulations of results are given for a representative group of cameras in RP1428 in the October number of the *Journal of Research*.

#### PRIORITIES IN MATERIALS FOR VEHICULAR LAMP AND SIGNAL EQUIPMENT

Under the auspices of the Civilian Allocation Division, Office of Production Management, a conference was held in Washington on September 11, on the conservation of strategic materials in the manufacture of lamps and signal equipment for vehicles. The conference listed the following items of equipment under headings to indicate the relative necessity of each group, and including some items which are necessary for a relatively small number of vehicles, weather conditions, or situations: I. Required by law or regulation for all vehicles—Headlamps, tail lamps, license-plate lamps, stop lamps, and rear-view mirrors. II. Required by law or regulation as additional equipment for commercial vehicles—(a) Regular items: Clearance lamps, marker lamps, identification lamps, reflex reflectors, and direction signals. (b) Emergency equipment: Oil-burning flares, red electric warning lanterns, reflective flares, fire extinguishers, hand axes, first-aid kits, fuzes, flags, skid chains (also needed for passenger vehicles), defrosters (also needed for passenger vehicles), tow chains, and tools for ordinary road repairs. III. Safety devices—(a) Outside of vehicle, permissible if approved by State or regulatory body: Fog lamps (adverse-weather lamps), supplementary driving and passing lamps, parking lamps, spot lamps, turn indicators, back-up lamps, back-up alarms, and burglar alarms. (b) Inside of vehicle: Instrument panel lights, dome lights, and destination lights. IV. Catchpenny items of equipment—Believed unessential to safety: Fender guides, exhaust defectors, ornamental radiator emblems, ornamental gearshift balls, license-plate rims and enclosures, and all novelty attachments.

The conference recommended that items falling under classification IV be considered as postponable needs and, as far as they involve strategic materials, should not be manufactured during the unlimited emergency. It was the con-

sensus that in order to conserve strategic materials: (a) The States should be requested to follow the Uniform Vehicle Code as to kind and number of items required, and (b) items manufactured during the emergency should conform to Nationally recognized standard minimum specifications.

Mr. Smiley stated that materials would be allocated for production of essential items of lamps and signal equipment necessary for the safety of vehicles.

Those attending the conference were: John B. Smiley, Civilian Allocation Division, OPM (chairman); Frank H. Crockard, Civilian Allocation Division, OPM; Robert Beatty, Metal Section, OPM; H. H. Allen, Safety Section, Bureau of Motor Carriers, Interstate Commerce Commission; R. S. Armstrong, manager, Safety Equipment Manufacturers Assn.; I. J. Fairchild, chief, Division of Trade Standards, National Bureau of Standards; L. S. Harris, executive director, American Association of Motor Vehicle Administrators; J. L. Koubek, Guide Lamp Division, General Motors Corporation (representing Automobile Manufacturers' Assn.); James J. Shanley, chief, Testing Division, Department of Motor Vehicles, Trenton, N. J., also chairman, Engineering Commission, American Association of Motor Vehicle Administrators.

#### CONSERVATION OF GASOLINE

The Bureau is cooperating with the Office of the Petroleum Coordinator in the consideration of suggestions received for conserving motor gasoline.

As the result of a conference between representatives of the OPC and the Bureau, the latter is considering only the technical merits of these suggestions. Whether a particular device should be approved, whether its manufacture should be encouraged, and whether its use should be recommended to any group or groups, are matters which are decided by the OPC. All tests are made for the information of the Petroleum Coordinator, and no reports are made to other interested parties by the Bureau.

#### ISOLATION OF HYDROCARBONS IN KEROSENE FRACTION OF PETROLEUM

A second report of the work on hydrocarbons in the kerosene fraction of petroleum, which is being carried on at the Bureau as part of the American

Petroleum Institute Research Project 6, appears as RP1423 by Beveridge J. Mair and Anton J. Streiff, in the October number of the Journal of Research.

Four hydrocarbons, 1,2,3,4-tetramethylbenzene, 5,6,7,8-tetrahydronaphthalene, 2-methyl-5,6,7,8-tetrahydronaphthalene, and 1-methyl-5,6,7,8-tetrahydronaphthalene, were separated by azeotropic distillation, followed by crystallization, of narrow-boiling fractions of aromatic material which (J. Research NBS 24, 392 (1940) RP1289)

had been separated by extraction and absorption from that part of the petroleum which distilled between 114° to 144° C at 56 mm Hg (corresponding approximately to 200° to 230° C at 760 mm Hg). Best lots of each of these four hydrocarbons from petroleum were prepared, and synthetic lots of three of them were purified for purposes of identification and determination of properties. The amounts of impurity in these various lots of material were determined as follows, in mole fraction:

Hydrocarbon	From petroleum	From synthetic material
1,2,3,4-Tetramethylbenzene	0.0006±0.0001	
5,6,7,8-Tetrahydronaphthalene	0.015±0.002	0.0057±0.0008
1-Methyl-5,6,7,8-tetrahydronaphthalene	0.0029±0.0004	0.0034±0.0005
2-Methyl-5,6,7,8-tetrahydronaphthalene	0.0046±0.0007	0.031 ±0.004

Values of certain physical properties of these four hydrocarbons, all extrapolated to zero impurity, were determined as follows:

Property	1,2,3,4-Tetramethylbenzene	5,6,7,8-Tetrahydronaphthalene	1-Methyl-5,6,7,8-tetrahydronaphthalene	2-Methyl-5,6,7,8-tetrahydronaphthalene
Boiling point at 760 mm, °C	205.04 ±0.03	207.57 ±0.10	234.35 ±0.05	229.03 ±0.05
Freezing point in air at 1 atm, °C	-6.25 ±0.01	-35.80 ±0.02	-22.90 ±0.03	-39.75 ±0.03
Density at 25° C, g/ml	0.9015 ±0.0001	0.9662±0.0002	0.9683 ±0.0002	0.9500 ±0.0002
Refractive index at 25° C:				
$n_D$	1.51362±0.00007	1.53466±0.00015	1.53738 ±0.00010	1.52920±0.00010
$n_F$	1.51811±0.00007	1.53919±0.00015	1.54190±0.00010	1.53365±0.00010
$n_H$	1.52223±0.00007	1.55065±0.00015	1.55325±0.00010	1.54498±0.00010
Specific dispersion at 25° C, $(n_F - n_D)/d$	0.01732±0.00005	0.01655±0.00010	0.01639±0.00005	0.01662±0.00005

### EFFECT OF BRAKE-DRUM ROUGHNESS ON WEAR OF BRAKE LININGS

A Research Paper (RP1427) in the Journal of Research for October gives the results of tests made by Rolla H. Taylor and William L. Holt to determine the relation between the wear of brake linings and the roughness of brake drums.

Five different linings were tested on the Bureau's small inertia testing machine with the following significant results: 1. In general, woven linings seem to be affected more by the roughness of the drums than molded linings. 2. The higher the initial value of roughness of the drum the greater will be the wear. In some cases the wear of a particular lining tested against commercially turned drums was approximately four times as great as when tested against drums which had been given a smooth finish by grinding, or so-

called superfinishing. 3. In making wear tests of brake lining, drums of uniform and equal roughness should be used. Furthermore, very smooth drums are greatly to be desired because they give more consistent results and less time is required to obtain reliable data.

These tests indicate that the life of brake lining in service could be increased considerably by the exclusive use of drums having roughness comparable with honed, superfinished, or finely ground drums.

### FAILURE OF GAGE ON OXYGEN TANK

The recent failure of an oxygen gage at the Bureau, resulting in injury to a member of its staff, calls attention to a hazard which probably exists in various laboratories.

Gages used on oxygen tanks are liable to two sorts of explosion: (a) simple mechanical breakage under pressure

of the Bourdon tube within the gage, and (b) actual explosion due to ignition of oxygen-oil mixtures within the gage tube. Both types of explosion have occurred at the Bureau. The older gages, referring to the small gages 3 inches or less in diameter and on oxygen tanks or oxygen using devices, do not adequately protect the user from the results of breakage or explosion. In general, the fronts of the gages are liable to fly with hazards of glass or other mechanical injury. Newer gages are so designed as to avoid this danger, and most of the gages purchased in the past few years have this provision.

The hazard of the old gages still in use appears sufficient to warrant their being discarded and replaced by gages of the newer, protected design. There are two designs of the latter which have approval of the Underwriters' Laboratories. The better of these is known as the "Safety" back design, in which the back plate will open in case of excess pressure but is prevented from being thrown off so as to be a source of hazard.

In view of the hazards involved, the Bureau believes that all small gages (3 inches or less) used on high-pressure oxygen should be examined as to their age and design, and replaced by new safety back gages if they are not provided with this feature. It should be emphasized that *all* gages used with high-pressure oxygen should bear the following warning in a conspicuous place: "*Oxygen—Use no oil.*"

#### MILDEW RESISTANCE OF COTTON BAGS

The decision of the War Department to use cotton instead of jute for sandbags has raised several new questions for consideration, one of which is the ability of the cotton to resist attack by mildew. Mildew spores are a common constituent of the atmosphere, and readily attack cotton when the moisture conditions are right. Preventatives, such as copper naphthanate, have been shown to be satisfactory and are in commercial use, and a requirement for mildew-proofness is included in a few Federal specifications. Formerly, tests for this property were made for the Bureau by the Department of Agriculture, where many years have been spent in developing mildew-proofing agents and testing methods. However, the job of testing sandbags for the Army is so big and the demand for speed so great, that the former method of opera-

tion is impractical. The Bureau can no longer make all of the other tests and farm out the mildew test to the Department of Agriculture. Therefore, an agreement has been reached with that Department, under which they will continue their research and development work, but the Bureau will do all of the testing. This has involved setting up a new laboratory where sterile conditions can be maintained, and providing additional equipment and personnel.

#### CHANGES IN AQUEOUS EXTRACTS STORED IN GLASS BOTTLES

Many liquids upon storage in glass containers have been known, at times, to undergo unexpected and undesirable changes in appearance, odor, composition, and alkalinity. Beverages have developed "flakes" high in silica content, which are objectionable from the standpoint of appearance of the product. Neutral saline solutions prepared for intravenous injection have also developed these flakes and have even become toxic because of changes in alkalinity. Serums have undergone alkalinity shifts with accompanying changes in composition, color, and potency; and culture media have shown changes in pH sufficient to render them useless. Since the source of most of these objectionable features has been traced to the quality of glass from which the containers were made, reliable methods for determining the chemical durability of glass are needed.

In developing such methods for determining the suitability of glass containers for storing liquids, much attention has been given to evaluating the quantity of alkali extracted from the inner surface by distilled water. In a recent investigation by Edgar H. Hamilton and Donald Hubbard of the Bureau's Glass Section, "direct" and "back" titrations of aqueous extracts have been made potentiometrically and with a series of common dye indicators to determine and illustrate what precautions are necessary to obtain reproducible and reliable results. In addition, the results obtained by titration procedures have been compared with conductivity measurements on aqueous extracts from bottles, and these comparisons throw much additional light on the reliability and shortcomings of these two methods.

A paper on this subject (RP1426) will be published in the October Journal of Research.

### THERMAL EXPANSION OF BORIC OXIDE GLASS AND OF CRYSTALLINE BORIC OXIDE

James J. Donoghue and Donald Hubbard have been making expansion studies of a boric oxide glass and a sample of crystalline boric oxide, using the Fizeau-Pulfrich interference method. The characteristics of the expansion curves for these two materials were found to be very different; the boric oxide glass has a "critical temperature" near 235° C followed by a very long "neck" with a softening temperature near 320° C, while the crystalline boric oxide has a melting point at 450° to 451° C. This melting temperature for crystalline boric oxide agrees very closely with the value of  $450 \pm 2^\circ$  C reported by F. C. Kracke, G. W. Morey, and H. E. Merwin, but differs materially from the value of 294° C offered by S. S. Cole and N. W. Taylor. The discrepancy between these two values reported for crystalline boric oxide is interpreted in light of the endothermic reaction accompanying the rapid expansion region of fused boric oxide.

The crystalline boric oxide, upon being heated to its melting point, does not return to the crystalline state when cooled but hardens to a glass. This fact is indicated by comparison of the expansion curves obtained on specimens of the crystalline boric oxide before and after being heated to 451° C. The detailed report of these measurements will be published as RP1425 in the October number of the Journal of Research.

### EFFECTS OF SALTS ON QUINONE SULFONATES

Certain dyes, called indicators, change color markedly when their ionization is effected by the presence of acids or bases. Chemists, therefore, use them in estimating acidity or hydrogen-ion concentration. However, even neutral salts effect a small change in the color of dyes, independent of their ionization, and strong acids behave like neutral salts in producing this secondary effect. This must be taken into account in precise determinations of hydrogen-ion concentration.

An investigation by Baker Wingfield and S. F. Acree is concerned with these secondary effects of acids and salts. As explained in the report of this work (RP1424) in the October Journal of Research, it was initiated on an organic compound,  $\beta$ -naphthoquinonesulfonic acid, which, though not an indicator, contains certain groups common to a large

class of indicators but is less complex than the useful members of that group. Thus overlapping absorption bands were avoided, and the measurements of the salt effects were simplified.

The absorption of light by the dye increased with increase of concentration of the salt or acid. In the presence of acids and salts, new absorption bands for the dye did not develop in the visible or ultraviolet. The data suggest that the specific effects of ions on the absorption indices of positive, neutral, and negatives forms of an indicator must be taken into account, as well as the normal effects of the ions on the dissociation of the indicator, for accurate pH measurements.

### REVISED SIMPLIFIED PRACTICE RECOMMENDATION FOR LARGE-TUBE CAST-IRON RADIATORS

Simplified Practice Recommendation R174-41, Large-Tube Cast-Iron Radiators, the first revision of this recommendation, covers a simplified schedule of sizes, dimensions, and ratings for four-, five-, six-, and seven-tube radiators. General provisions with respect to hydrostatic test pressure, tapings, pipe fittings, etc., and a sketch illustrating the types and dimensions of these radiators, are given.

As originally promulgated in March 1940, the recommendation established a simplified list of 17 stock sizes out of a total of 33 sizes in production at that time. It was based on a thorough study of requirements of builders and home owners, made by the Institute of Boiler and Radiator Manufacturers, who proposed the project.

The current revision, which became effective on October 1, 1941, further reduces the number of stock varieties to 13 by the elimination of 4 sizes—the 4-tube, 20-inch; 6-tube, 20-inch; 7-tube, 17-inch; and 7-tube, 28-inch radiators. In addition to the list of stock sizes, the publication briefly outlines the development of the project and lists the members of the standing committee and the acceptors of the recommendation.

Until the printed recommendation is available, free mimeographed copies may be obtained from the Division of Simplified Practice, National Bureau of Standards, Washington, D. C.

### SOIL-CORROSION STUDIES

Kirk H. Logan, chief of the Bureau's Soil Corrosion Section, is now on his biennial trip for the removal of soil-



corrosion specimens and burial of new ones. The samples which are being placed in the ground this fall include six varieties of cast iron containing different percentages of nickel, copper, and carbon; three alloy steels; and a special lead alloy. At some test sits, sets of zinc-iron couples are also being installed, on which observations will be made to determine the current densities required for protecting pipes by the use of zinc.

Interest in this subject is growing, and the application of the results of the soil-corrosion studies has been widespread. By invitation, papers on different phases of the work were presented at a special research conference on corrosion, which was held during August at Gibson Island, Md., under the auspices of the National Research Council. The Federal Power Commission is particularly concerned with these studies because of their bearing on the valuation of pipe lines used for transmitting gas. One of the Commission's engineers spent over 2 weeks at the Bureau making measurements on samples of soil.

#### EDUCATIONAL COURSES, 1941-42

The following educational courses are being offered at the Bureau during the school year 1941-42. The first two courses, Theory of Functions and Metallurgy, will definitely be given. The remaining courses are offered tentatively, subject to sufficient registration:

**Course A. Theory of Functions**—W. Edwards Deming. Thirty lectures, once weekly throughout the year. Time: Tuesdays at 7 p. m. in the Chemistry Lecture Room (Room 214). Prerequisite: Calculus. Text: MacRobert's Functions of a complex variable.

Topics: Calculus will be reviewed as necessary. Complex numbers. Mapping, conformal representation. Branches and singularities, poles and zeros. Theory of limits, Sequences. Conversion and uniform convergence. Line, surface, and volume integrals. Theory of integration. Definite integrals by residues. Series; tests for convergence; summations and expansions by residues. Taylor's and Laurent's series. Fourier series. Analytic continuation. The Bernaulli numbers, Euler numbers. The complete and incomplete Gamma and Beta Functions; evaluation by expansions and by continued fractions. Some work in finite differences. The Euler-MacLaurin summation. Asymptotic expansions and

approximations. Summability. The hypergeometric equation. Elliptic integrals and the Jacobian elliptic functions. Applications to mechanics, electrostatics and probability. The history of each topic will be emphasized.

**Course B. Principles of Physical Metallurgy**—Victor H. Gottschalk. Sixty lectures given 2 hours per week. Tuesdays and Thursdays at 4:30 p. m. in Room 301, Industrial Building. Text: No special textbook will be required.

Topics: Development, meaning, and use of equilibrium diagrams for binary alloys. The iron-carbon diagrams and their relation to cast iron and steel, and to the critical points important in heat-treating ferrous alloys. Steel-treating processes depending on non-equilibrium conditions, including the S-curve. The alloy steels. Aging and precipitation hardening. Segregation and other ingot defects. Mechanical and physical tests, including the interpretation of micrographs. Nonferrous alloys of industrial importance.

**Course C. Theoretical Mechanics**—F. G. Brickwedde. Sixty hours of lectures given 2 hours per week throughout the year. Tentative times: Tuesdays, 4:15-6:15, or Tuesdays and Thursdays, 4:15-5:15, to suit the convenience of the class. Prerequisite: Calculus. Text: Mechanics, by W. F. Osgood. The text will be on the reserve shelf in the library for inspection.

Topics: The course will cover the fundamental principles of statics, kinematics, and dynamics. Lagrange's and Hamilton's generalized equations of mechanics will be included. Consideration will be given to topics of general application and interest, such as motion in central fields of force; vibrational motion; wave motion; gyroscope and top. Applications of the equations of mechanics in other branches of physics will be illustrated.

**Course D. Chemical Thermodynamics**—Frederick D. Rossini. Sixty lectures given 2 hours per week throughout the year. Tentative time: Mondays, 4:10 to 6 p. m., in the Chemistry Lecture Room. Text: Students will not be required to purchase textbooks for this course.

Topics: This course deals with the principles and methods of chemical thermodynamics, including the newer developments. Emphasis is laid upon the utilization of the tools of chemical thermodynamics in the solution of the many diverse problems encountered in chemistry which are susceptible of thermodynamic treatment.

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Gages used on oxygen tanks are liable to two sorts of explosion: (a) simple mechanical breakage under pressure



of the Bourdon tube within the gage, and (b) actual explosion due to ignition of oxygen-oil mixtures within the gage tube. Both types of explosion have occurred at the Bureau. The older gages, referring to the small gages 3 inches or less in diameter and on oxygen tanks or oxygen using devices, do not adequately protect the user from the results of breakage or explosion. In general, the fronts of the gages are liable to fly with hazards of glass or other mechanical injury. Newer gages are so designed as to avoid this danger, and most of the gages purchased in the past few years have this provision.

The hazard of the old gages still in use appears sufficient to warrant their being discarded and replaced by gages of the newer, protected design. There are two designs of the latter which have approval of the Underwriters' Laboratories. The better of these is known as the "Safety" back design, in which the back plate will open in case of excess pressure but is prevented from being thrown off so as to be a source of hazard.

In view of the hazards involved, the Bureau believes that all small gages (3 inches or less) used on high-pressure oxygen should be examined as to their age and design, and replaced by new safety back gages if they are not provided with this feature. It should be emphasized that all gages used with high-pressure oxygen should bear the following warning in a conspicuous place: "Oxygen—Use no oil."

#### MILDEW RESISTANCE OF COTTON BAGS

The decision of the War Department to use cotton instead of jute for sandbags has raised several new questions for consideration, one of which is the ability of the cotton to resist attack by mildew. Mildew spores are a common constituent of the atmosphere, and readily attack cotton when the moisture conditions are right. Preventatives, such as copper naphthanate, have been shown to be satisfactory and are in commercial use, and a requirement for mildew-proofness is included in a few Federal specifications. Formerly, tests for this property were made for the Bureau by the Department of Agriculture, where many years have been spent in developing mildew-proofing agents and testing methods. However, the job of testing sandbags for the Army is so big and the demand for speed so great, that the former method of opera-

tion is impractical. The Bureau can no longer make all of the other tests and farm out the mildew test to the Department of Agriculture. Therefore, an agreement has been reached with that Department, under which they will continue their research and development work, but the Bureau will do all of the testing. This has involved setting up a new laboratory where sterile conditions can be maintained, and providing additional equipment and personnel.

#### CHANGES IN AQUEOUS EXTRACTS STORED IN GLASS BOTTLES

Many liquids upon storage in glass containers have been known, at times, to undergo unexpected and undesirable changes in appearance, odor, composition, and alkalinity. Beverages have developed "flakes" high in silica content, which are objectionable from the standpoint of appearance of the product. Neutral saline solutions prepared for intravenous injection have also developed these flakes and have even become toxic because of changes in alkalinity. Serums have undergone alkalinity shifts with accompanying changes in composition, color, and potency; and culture media have shown changes in pH sufficient to render them useless. Since the source of most of these objectionable features has been traced to the quality of glass from which the containers were made, reliable methods for determining the chemical durability of glass are needed.

In developing such methods for determining the suitability of glass containers for storing liquids, much attention has been given to evaluating the quantity of alkali extracted from the inner surface by distilled water. In a recent investigation by Edgar H. Hamilton and Donald Hubbard of the Bureau's Glass Section, "direct" and "back" titrations of aqueous extracts have been made potentiometrically and with a series of common dye indicators to determine and illustrate what precautions are necessary to obtain reproducible and reliable results. In addition, the results obtained by titration procedures have been compared with conductivity measurements on aqueous extracts from bottles, and these comparisons throw much additional light on the reliability and shortcomings of these two methods.

A paper on this subject (RP1426) will be published in the October Journal of Research.

### THERMAL EXPANSION OF BORIC OXIDE GLASS AND OF CRYSTALLINE BORIC OXIDE

James J. Donoghue and Donald Hubbard have been making expansion studies of a boric oxide glass and a sample of crystalline boric oxide, using the Fizeau-Pulfrich interference method. The characteristics of the expansion curves for these two materials were found to be very different; the boric oxide glass has a "critical temperature" near 235° C followed by a very long "neck" with a softening temperature near 320° C, while the crystalline boric oxide has a melting point at 450° to 451° C. This melting temperature for crystalline boric oxide agrees very closely with the value of  $450 \pm 2^\circ$  C reported by F. C. Kracke, G. W. Morey, and H. E. Merwin, but differs materially from the value of 294° C offered by S. S. Cole and N. W. Taylor. The discrepancy between these two values reported for crystalline boric oxide is interpreted in light of the endothermic reaction accompanying the rapid expansion region of fused boric oxide.

The crystalline boric oxide, upon being heated to its melting point, does not return to the crystalline state when cooled but hardens to a glass. This fact is indicated by comparison of the expansion curves obtained on specimens of the crystalline boric oxide before and after being heated to 451° C. The detailed report of these measurements will be published as RP1425 in the October number of the Journal of Research.

### EFFECTS OF SALTS ON QUINONE SULFONATES

Certain dyes, called indicators, change color markedly when their ionization is effected by the presence of acids or bases. Chemists, therefore, use them in estimating acidity or hydrogen-ion concentration. However, even neutral salts effect a small change in the color of dyes, independent of their ionization, and strong acids behave like neutral salts in producing this secondary effect. This must be taken into account in precise determinations of hydrogen-ion concentration.

An investigation by Baker Wingfield and S. F. Acree is concerned with these secondary effects of acids and salts. As explained in the report of this work (RP1424) in the October Journal of Research, it was initiated on an organic compound,  $\beta$ -naphthoquinonsulfonic acid, which, though not an indicator, contains certain groups common to a large

class of indicators but is less complex than the useful members of that group. Thus overlapping absorption bands were avoided, and the measurements of the salt effects were simplified.

The absorption of light by the dye increased with increase of concentration of the salt or acid. In the presence of acids and salts, new absorption bands for the dye did not develop in the visible or ultraviolet. The data suggest that the specific effects of ions on the absorption indices of positive, neutral, and negative forms of an indicator must be taken into account, as well as the normal effects of the ions on the dissociation of the indicator, for accurate pH measurements.

### REVISED SIMPLIFIED PRACTICE RECOMMENDATION FOR LARGE-TUBE CAST-IRON RADIATORS

Simplified Practice Recommendation R174-41, Large-Tube Cast-Iron Radiators, the first revision of this recommendation, covers a simplified schedule of sizes, dimensions, and ratings for four-, five-, six-, and seven-tube radiators. General provisions with respect to hydrostatic test pressure, tapings, pipe fittings, etc., and a sketch illustrating the types and dimensions of these radiators, are given.

As originally promulgated in March 1940, the recommendation established a simplified list of 17 stock sizes out of a total of 33 sizes in production at that time. It was based on a thorough study of requirements of builders and home owners, made by the Institute of Boiler and Radiator Manufacturers, who proposed the project.

The current revision, which became effective on October 1, 1941, further reduces the number of stock varieties to 13 by the elimination of 4 sizes—the 4-tube, 20-inch; 6-tube, 20-inch; 7-tube, 17-inch; and 7-tube, 28-inch radiators. In addition to the list of stock sizes, the publication briefly outlines the development of the project and lists the members of the standing committee and the acceptors of the recommendation.

Until the printed recommendation is available, free mimeographed copies may be obtained from the Division of Simplified Practice, National Bureau of Standards, Washington, D. C.

### SOIL-CORROSION STUDIES

Kirk H. Logan, chief of the Bureau's Soil Corrosion Section, is now on his biennial trip for the removal of soil-

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corrosion specimens and burial of new ones. The samples which are being placed in the ground this fall include six varieties of cast iron containing different percentages of nickel, copper, and carbon; three alloy steels; and a special lead alloy. At some test sites, sets of zinc-iron couples are also being installed, on which observations will be made to determine the current densities required for protecting pipes by the use of zinc.

Interest in this subject is growing, and the application of the results of the soil-corrosion studies has been widespread. By invitation, papers on different phases of the work were presented at a special research conference on corrosion, which was held during August at Gibson Island, Md., under the auspices of the National Research Council. The Federal Power Commission is particularly concerned with these studies because of their bearing on the valuation of pipe lines used for transmitting gas. One of the Commission's engineers spent over 2 weeks at the Bureau making measurements on samples of soil.

#### EDUCATIONAL COURSES, 1941-42

The following educational courses are being offered at the Bureau during the school year 1941-42. The first two courses, Theory of Functions and Metallurgy, will definitely be given. The remaining courses are offered tentatively, subject to sufficient registration:

**Course A. Theory of Functions**—W. Edwards Deming. Thirty lectures, once weekly throughout the year. Time: Tuesdays at 7 p. m. in the Chemistry Lecture Room (Room 214). Prerequisite: Calculus. Text: MacRobert's Functions of a complex variable.

Topics: Calculus will be reviewed as necessary. Complex numbers. Mapping, conformal representation. Branches and singularities, poles and zeros. Theory of limits, Sequences. Conversion and uniform convergence. Line, surface, and volume integrals. Theory of integration. Definite integrals by residues. Series; tests for convergence; summations and expansions by residues. Taylor's and Laurent's series. Fourier series. Analytic continuation. The Bernaulli numbers, Euler numbers. The complete and incomplete Gamma and Beta Functions; evaluation by expansions and by continued fractions. Some work in finite differences. The Euler-MacLaurin summation. Asymptotic expansions and

approximations. Summability. The hypergeometric equation. Elliptic integrals and the Jacobian elliptic functions. Applications to mechanics, electrostatics and probability. The history of each topic will be emphasized.

**Course B. Principles of Physical Metallurgy**—Victor H. Gottschalk. Sixty lectures given 2 hours per week. Tuesdays and Thursdays at 4:30 p. m. in Room 301, Industrial Building. Text: No special textbook will be required.

Topics: Development, meaning, and use of equilibrium diagrams for binary alloys. The iron-carbon diagrams and their relation to cast iron and steel, and to the critical points important in heat-treating ferrous alloys. Steel-treating processes depending on non-equilibrium conditions, including the S-curve. The alloy steels. Aging and precipitation hardening. Segregation and other ingot defects. Mechanical and physical tests, including the interpretation of micrographs. Nonferrous alloys of industrial importance.

**Course C. Theoretical Mechanics**—F. G. Brickwedde. Sixty hours of lectures given 2 hours per week throughout the year. Tentative times: Tuesdays, 4:15-6:15, or Tuesdays and Thursdays, 4:15-5:15, to suit the convenience of the class. Prerequisite: Calculus. Text: Mechanics, by W. F. Osgood. The text will be on the reserve shelf in the library for inspection.

Topics: The course will cover the fundamental principles of statics, kinematics, and dynamics. Lagrange's and Hamilton's generalized equations of mechanics will be included. Consideration will be given to topics of general application and interest, such as motion in central fields of force; vibrational motion; wave motion; gyroscope and top. Applications of the equations of mechanics in other branches of physics will be illustrated.

**Course D. Chemical Thermodynamics**—Frederick D. Rossini. Sixty lectures given 2 hours per week throughout the year. Tentative time: Mondays, 4:10 to 6 p. m., in the Chemistry Lecture Room. Text: Students will not be required to purchase textbooks for this course.

Topics: This course deals with the principles and methods of chemical thermodynamics, including the newer developments. Emphasis is laid upon the utilization of the tools of chemical thermodynamics in the solution of the many diverse problems encountered in chemistry which are susceptible of thermodynamic treatment.

The plan of study includes: The energy, heat content, entropy, and free energy of pure substances and solutions, in the gaseous, liquid, and solid states, including partial molal quantities; equilibria in chemical reactions; the electromotive force of cells and standard electrode potentials; the third law; the statistical calculation of thermodynamic properties from spectroscopic and other molecular data; the data of chemical thermodynamics; units of energy.

Because of the general emergency, the buildings and grounds of the National Bureau of Standards are open to the interested public only under certain definite restrictions. In view of this, these courses can be made available only to citizens of the United States. Those desiring to attend any course should telephone Woodley 1720, branch 43. Temporary passes will be issued to those actually enrolled.

The fee for each course will be \$20. This amount may be paid in two installments, \$12 on or before November 1, 1941, and \$8 on or before March 1, 1942. The fee for a 30-hour course will be \$12. These fees are charged for attendance at sessions of class, and there is no reduction if credit is not desired.

#### NEW AND REVISED PUBLICATIONS ISSUED DURING SEPTEMBER 1941

##### Journal of Research<sup>2</sup>

Journal of Research of the National Bureau of Standards, volume 27, number 2, August 1941 (RP1406 to RP1414, inclusive). Price 30 cents. Annual subscription, 12 issues, \$3.50.

Journal of Research of the National Bureau of Standards, volume 27, number 2, September 1941 (RP1415 to RP1422, inclusive). Price 30 cents.

##### Research Papers<sup>2</sup>

[Reprints from July and August 1941 Journal of Research]

RP1398. Enzymatic hydrolysis of disaccharides and halogenosalicins. William Ward Pigman. Price 5 cents.

RP1399. Optical rotatory relationships exhibited by aromatic and aliphatic

glycosides. William Ward Pigman and Horace S. Isbell. Price 10 cents.

RP1400. Effect of the chemical durability of glass on the asymmetry potential and reversibility of the glass electrode. Edgar H. Hamilton and Donald Hubbard. Price 5 cents.

RP1401. An improvement in the "partition method" for the determination of boron. Francis W. Glaze and Alfred N. Finn. Price 5 cents.

RP1402. Separation of hydrocarbons by azeotropic distillation. Beveridge J. Mair, Augustus R. Glasgow, Jr., and Frederick D. Rossini. Price 10 cents.

RP1403. Microstructural characteristics of high-purity alloys of iron and carbon. Thomas G. Digges. Price 10 cents.

RP1404. Photochemical reactions in silk. Henry A. Rutherford and Milton Harris. Price 5 cents.

RP1405. Role of cystine in the structure of the fibrous protein, wool. Wilbur I. Patterson, Walton B. Geiger, Louis R. Mizell, and Milton Harris. Price 10 cents.

RP1406. Quantitative determination of fluorine in organic compounds. Dirk H. Brauns. Price 5 cents.

RP1408. Chemical reactions of the chlorites with carbohydrates. Allene Jeanes and Horace S. Isbell. Price 10 cents.

##### Simplified Practice Recommendations<sup>2</sup>

R106-41. Hospital plumbing fixtures. (Supersedes R106-30.) Price 5 cents.

R180-41. Copper conductors for building purposes. Price 5 cents.

##### Commercial Standards<sup>2</sup>

CS11-41. Moisture regains of cotton yarns. (Supersedes CS11-29.) Price 5 cents.

CS95-41. Lead pipe. Price 5 cents.

CS96-41. Lead traps and bends. Price 5 cents.

##### Technical News Bulletin<sup>2</sup>

Technical News Bulletin 292, August 1941. Price 5 cents. Annual subscription, 50 cents.

Technical News Bulletin 293, September 1941. Price 5 cents.

#### MIMEOGRAPHED MATERIAL

##### Letter Circulars

[Letter Circulars are prepared to answer specific inquiries addressed to the National Bureau of Standards and are sent only on request to persons having definite need for

<sup>2</sup> Send orders for publications under this heading only to the Superintendent of Documents, Government Printing Office, Washington, D. C. Subscription to Technical News Bulletin, 50 cents per year; Journal of Research, \$3.50 per year (to addresses in the United States and its possessions and to countries extending the franking privilege); other countries, 70 cents and \$4.50, respectively.

the information. The Bureau cannot undertake to supply lists or complete sets of Letter Circulars or send copies automatically as issued.]

LC857. National Bureau of Standards specification for proving rings for calibrating testing machines. (Supersedes LC548.)

LC858. Radio distance ranges, summer 1941 and winter 1941-42. (Supersedes LC615.)

LC859. Paint, varnish, and bituminous materials: Publications by members of the staff of the National Bureau of Standards and a list of Federal Specifications. (Supersedes LC574.)

# RECENT BUREAU ARTICLES APPEARING IN OUTSIDE PUBLICATIONS\*

The present status of combustion research. Ernest F. Fiock. Soc. Automotive Engineers J. (29 West 39th St., New York, N. Y.) 49, 332 (August 1941).

Airport lighting in the United States and Europe. F. C. Breckenridge. Preprint of paper presented before thirty-fifth annual convention, Illuminating Engineering Society (51 Madison Ave., New York, N. Y.) September 24, 1941.

\* These publications are not obtainable from the Government. Requests should be sent direct to the publishers.

A stable photoelectric amplifier and its application in ultraviolet and ozone studies. R. Stair and I. F. Hand, Bul. Am. Meteorological Soc. (Milton, Mass.) 22, No. 6, 259 (June 1941).

Transcendental mechanics, Paul R. Heyl. Am. J. Physics (Columbia University, New York, N. Y.) 9, No. 4, 217 (August 1941).

Compressive properties, perforated cover plates for steel columns. Progress Report No. 1. Committee on Technical Research. Am. Inst. Steel Construction (New York, N. Y.) Publication No. 173 (August 1941).

Table of lattice constants. Compiled by H. C. Vacher. Third installment. Metal Progress (Am. Soc. for Metals, 7301 Euclid Ave., Cleveland, Ohio) 40, No. 2, insert p. 187 (August 1941).

The tensile-elastic properties at low temperatures of 18:8 chromium-nickel steel, as affected by heat treatment and by slight plastic extension. R. W. Mebs and D. J. McAdam, Jr. Nat. Advis. Com. Aeronautics (Washington, D. C.) Technical Note 818 (August 1941).

Note on moisture expansion of ceramic whiteware in storage and in service. R. F. Geller and A. S. Creamer. J. Am. Ceramic Soc. (2525 North High St., Columbus, Ohio) 24, No. 3, 77 (March 1941).

Simplification as a defense aid. W. E. Braithwaite. Modern Packaging (122 East 42d St., New York, N. Y.) 15, No. 1, 42 (September 1941).





